6. SPECIAL FACILITIES

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6. SPECIAL FACILITIES

6.1 OVERVIEW

Seven major facilities that are used in research programs at EML are described in this section. Four of these are stationary, and are located in EML's quarters in New York City. Two of the facilities are mobile and are used in field sampling/measurement work all over the U.S. The seventh facility is an outdoor laboratory located in rural New Jersey.

6.2 RADON GAS AND RADON/THORON PROGENY FACILITIES FOR TESTING AND RESEARCH

Contact Person(s) : Isabel M. Fisenne and Alfred J. Cavallo

6.2.1 SCOPE

Two major on-site EML facilities that are used for research on Rn gas measurements, instruments, and methods are described here (the pulse ionization chamber facility and the Rn, Th, and progeny exposure facilities).

6.2.2 THE EML PULSE IONIZATION CHAMBER FACILITY FOR RADON-222 MEASUREMENTS

6.2.2.1 INTRODUCTION

The pulse ionization chamber facility is used for the direct measurement of environmental levels of ^{222}Rn in air and breath samples. The chambers are calibrated periodically by de-emanating Rn gas from Ra solutions certified by the National Institute of Standards and Technology (NIST). Thus, the facility also serves as the EML reference for Rn gas measurements, and values so obtained are considered to be EML's best estimate of the Rn activity in a sample.

The following discussion will be confined to the direct measurement of ^{222}Rn in air samples as part of an integrated calibration facility. A fuller description of the EML pulse ionization chamber facility can be found in Fisenne and Keller (1985).

6.2.2.2 PRINCIPLE OF OPERATION

The EML pulse ionization chamber is operated on the principle of fast pulse counting (Curtiss and Davis, 1943). Fast pulse counting is based on direct detection of the α ionization produced in a single ionization chamber. To accomplish fast pulse counting, it is mandatory that O_2 and water vapor be removed before a sample is introduced into the chamber.

6.2.2.3
DESIGN

The EML pulse ionization chambers, which are shown in Figure 6.1, are constructed of stainless steel. The interior surface is electropolished to remove surface contamination and to lower the background count rate, which is the limiting factor for measurement sensitivity. Clean chambers have a background of about 10 counts h^{-1}.

The EML chambers are constructed with a plug in the baseplate to accommodate an electrodeposited standard source for the determination of the α counting plateau. The α detection efficiency of the chambers with such a source is 52%.

The transfer systems for the removal of O_2 and water vapor are designed to meet three criteria: simplicity; a small ratio of dead space to chamber volume; and dichotomy, that is, access to one or two ionization chambers.

6.2.2.4
PROCEDURE

For direct transfer and measurement to a single chamber, the air or breath sample volume is restricted to 1 L or less. Sample transfer is accomplished by evacuating the entire system, including the ionization chambers. Pure H_2 gas is added to the sample container (35 kPa of H_2). The sample is transferred through the system with forming gas (85% N_2, 15% H_2). The gas flow rate through the system is regulated by a capillary orifice and small particles are removed by a filter paper. The added excess H_2 and the O_2 in the sample react in the platinum black catalyst cartridges to produce H_2O and excess heat. The H_2O formed in the catalytic reaction is removed in a Drierite column. The gas is collected in a single ionization chamber which is pressurized to 35 kPa with forming gas. A block diagram of the ionization chamber and external transfer apparatus is shown in Section 4, Procedure Rn-01-RC in which the details of the procedure for the measurement of air samples are described.

6.2.2.5
CALIBRATION

The EML pulse ionization chambers are calibrated with NIST standard reference material (SRM) ^{226}Ra solutions using the Rn emanation technique (see Section 4, Procedure Ra-07-RC). In April 1984, NIST issued a new series of SRM ^{226}Ra solutions for Rn emanation measurements. As part of EML's internal quality control program, a major effort was undertaken to determine the calibration factor for the nine ionization chambers currently in use. The overall mean and standard deviation of 81 emanations into the nine chambers was 6245 ± 135 counts h^{-1} per Bq of ^{222}Rn in equilibrium with its short-lived progeny. This value was in excellent agreement with previous calibrations.

6.2.2.6 ROUTINE CHAMBER CHECKS AND MAINTENANCE

The backgrounds of the nine pulse ionization chambers are measured with forming gas each weekend and occasionally during the work week to ensure against temporal biases. The backgrounds for the nine chambers in service range from 8-16 counts h^{-1}. A control chart of the weekend background count rates is maintained for each chamber. At the beginning of the calendar year, the yearly average and running average background rates from previous years are calculated and control limits are established for the year.

Over a period of years, the background of any chamber increases due to the buildup of long-lived Rn progeny on the interior surfaces. The background increase is a function of exposure in terms of ^{222}Rn Bq h^{-1} in the chamber, that is, 0.037 Bq of ^{222}Rn in a chamber for 17 h will produce 2.2×10^{-6} Bq of ^{210}Pb. After 1 y, the ^{210}Po will have reached 82% of the ^{210}Pb activity and will contribute an additional 3×10^{-3} counts h^{-1} to the chamber background. Fractions or multiples of the .037 Bq of ^{222}Rn example are additive in the total temporal increase of the chamber background count rate. The background count rate is reduced by dismantling and electropolishing the chamber.

The platinum black catalyst and Drierite are kept free of water vapor by maintaining these cartridges under vacuum, except during sample introduction into a chamber.

The chamber systems are checked occasionally for electrically generated noise by filling the chambers with room air. The O_2 in the air effectively reduces the pulse sizes below the 0.75 V tripping level of the electronic system and only electrically generated pulses are registered during the overnight measurement period. The electrical noise in the chamber system is < 0.25 counts h^{-1}.

Throughout the year the calibration factor of each chamber is checked by emanating Rn from a standard Ra emanation flask.

6.2.3 RADON, THORON, AND PROGENY EXPOSURE FACILITY

6.2.3.1 INTRODUCTION

The EML radon, thoron, and progeny exposure facility consists of a walk-in chamber that is used for research, testing, calibration, and for the evaluation of measuring instruments.

The 30 m^3 chamber, installed in 1993, provides for a well-controlled, clean, airtight, and uniform test environment. Research with inert aerosols and other pollutants can also be carried out. Figure 6.2 shows the major features of the exposure facility.

6.2.3.2
DESCRIPTION OF THE EXPOSURE FACILITY

A. Radon and thoron gas sources.

Radon is generated from a Pylon (Model RN-1025, Ottawa, Ontario, Canada) ^{226}Ra source with 3810 kBq of radium. The source is sealed hermetically inside a container located on top of the chamber. The injection of radon into the mixing chamber is computer controlled to obtain the desired concentrations of radon inside the main chamber.

Thoron is generated from a Pylon (Model TH-1025) ^{228}Th source. The strength of the source was 1960 kBq at the time of acquisition. The source has to be recharged every 5 yr because of its short half-life. The thoron generator can be installed in different locations inside the main chamber in order to achieve the desired airborne thoron concentrations.

B. Design characteristics of the chamber.

A schematic diagram of the chamber is shown in Figure 6.2. The interior dimensions of the main exposure room are 3.3 m x 3.83 m x 2.59 m with a total volume of 30.75 m^3. The wall panels are made of enameled aluminum on the exterior, and 22 gauge stainless steel on the inside. The floor is constructed of 16 gauge stainless steel. The floors, walls, and ceiling are insulated to ensure minimum heating and cooling requirements.

The mixing room has a volume of 3.5 m^3. The anteroom, which has a volume of 5.8 m^3, serves as a means to transfer instruments in and out of the main chamber and as a buffer between the main chamber and the adjacent laboratory space. Two viewing windows, with triple panes, are located on the west wall. On the same wall there are 10 sampling ports that are 10 cm in diameter at a height of 1 m off the floor. A two-way audio system is provided for communication purposes.

C. Environmental control characteristics.

The environmental conditioning system (Fidelity Engineering, Hunt Valley, MD) consists of the following systems: refrigeration, heating, humidification, dehumidification, air delivery, control, and pressurization air.

The refrigeration system consists of a single air-cooled condensing unit, two refrigeration evaporator coils, and a refrigerant piping network. The cooling coils are made of copper with aluminum fins; the refrigerant is HCFC-22. All of the elements of the air conditioning system are constructed to minimize contamination. The compressor, condenser coils receiver, and filter dryer are located outside the chamber, adjacent to the mixing room (see Figure 6.2). The evaporator coils are inside the mixing room. The temperature in the main test chamber can be controlled from 5°C - 40°C. The difference in temperature anywhere within the chamber is no more than 1°C.

For humidification of the environment, water vapor is generated by an evaporative type system which is installed inside the mixing room. The system runs hot water across a screen-like surface and allows the water to evaporate into the air. The temperature of the water is kept below boiling. Dehumidification is accomplished by a refrigeration coil that becomes active only on call. It is isolated by a damper for the defrost cycle to avoid reintroduction of humidity during defrosting. The humidity is variable between a minimum that is determined by a -10°C dew point temperature and a maximum of 95%. The humidity inside the chamber is controlled to within 2 units of the set point during steady conditions.

The environmental conditioning system also has a hydronic hot water system located outside the test chamber. It consists of a small glass electric hot water heater of about 2000 W, a water circulation pump, a diaphragm expansion tank, and a filter. The hot water system is used to heat the test chamber air as needed.

The air delivery system, located in the mixing room, uses an in-line axial fan that can deliver a maximum of 30 m^3 min^{-1}. A typical operating range is 3-10 m^3 min^{-1}. In addition, a filtered pressurization air system is used to create a slight positive pressure in the main chamber to prevent uncontrolled infiltration.

D. Aerosol generator systems.

A TSI Model 3470 condensation monodisperse aerosol generator (TSI, St. Paul, MI) located outside the main chamber, is used to produce particles of the desired concentration and size. Vaporized Carnauba wax condenses on NaCl nuclei to produce monodisperse aerosols with a geometric standard deviation (σ_g) of around 1.1 or less. The concentration of the aerosols inside the test chamber can be controlled from 1,000 to 30,000 cm^3. If polydisperse aerosols are desired, the concentration can be increased to more than 100,000 cm^{-3}. The generated aerosols are injected through a sampling port hole into the main chamber. Aerosols from a burning candle, an electric heater, a kerosene lamp, or from cigarette smoke, can be generated individually or in combination by placing the generators inside the test chamber. The particle concentration inside the main chamber without any generated aerosol is < 200 cm^3.

E. Aerosol and vapor monitoring systems.

The aerosol concentration inside the main chamber is measured with an Environment One Rich Model 200 condensation nucleus counter, or a TSI Model 3025 ultra-fine particle counter. The size distribution of the test aerosol is measured with a TSI scanning mobility particle sizer. A Bruel & Kjaer Multi-gas Monitor Type 1302 is used to measure key organic pollutants. The detection limit depends on the type of pollutant and ranges from 0.001 - 1.0 ppm.

F. Radon control and monitoring systems.

The concentration of radon, thoron and progeny is regulated by adjusting the output from the radon generator. Radon is measured with two continuous scintillation cell monitors (cell volume = 0.096 and 3.3 L). The monitors are interfaced to a computer located at the control panel outside the chamber. The calibration and the accuracy of the radon monitors are based on intercomparisons made with pulse ionization chambers (see Section 6.2.2). The data are logged to a computer at 15-min intervals, and may be recalled at any time. Radon and thoron concentrations in the main chamber are adjustable in the range from 100 - 5000 Bq m^{-3}, and 50 - 5000 Bq m^{-3}, respectively.

The radon and thoron progeny concentrations are regulated by the dilution of the parent gases and by the presence of aerosols. The progeny concentrations are measured inside the main chamber by grab, integrating, and continuous monitoring devices. The standard monitoring instruments for radon and thoron progeny are the AlphaSmart-760 (Alpha Nuclear, Missisauga, Ontario, Canada) and the GRI-1100 monitor. The analyses for the individual radon and thoron progeny and the potential alpha energy concentrations are performed using the methods of Thomas (1972), Nazaroff (1983), and Raabe and Wrenn (1969). All three methods are computerized and the data are available on an hourly basis. The concentrations in the main chamber range from 5.6×10^{-9} J m^{-3} to 1.4×10^{-5} J m^{-3} for radon progeny, and 1×10^{-5} to 7×10^{-5} J m^{-3} for thoron progeny.

Because of the capability to maintain the test chamber at less than 200 particle cm^{-3}, the equilibrium factor as low 0.01 is achievable. At very high particle concentrations, an equilibrium factor of 0.5 is obtainable.

The sensors for temperature and humidity are located in the main test chamber and in the mixing room. The static pressure in the main chamber and the speed of the conditioned air exiting from the mixing room are monitored continuously. The data are automatically logged on the control computer.

G. Radon progeny particle size distribution measurements.

The test chamber particle size conditions can be measured with the micro-orifice uniform deposit impactor (MOUDI - see Section 2.2.2.5), EML developed screen diffusion batteries (see Section 2.2.2.6), and graded screen array (see Section 2.2.2.7). When used in combination, these instruments can measure radon and thoron progeny particle sizes ranging from 0.5 to 5000 nm (Tu and Knutson, 1994).

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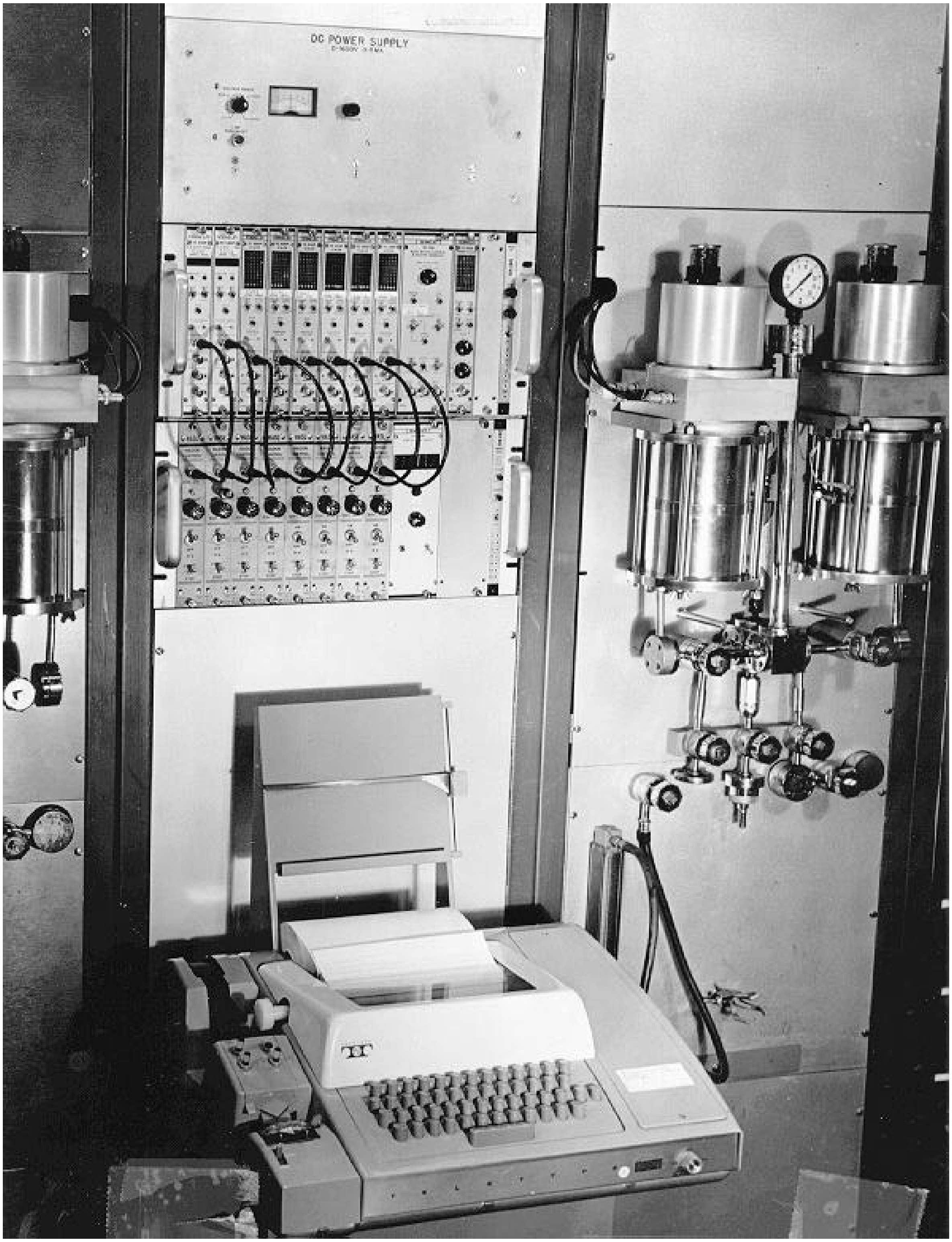

Figure 6.1 Photograph of pulse ionization chamber facility.

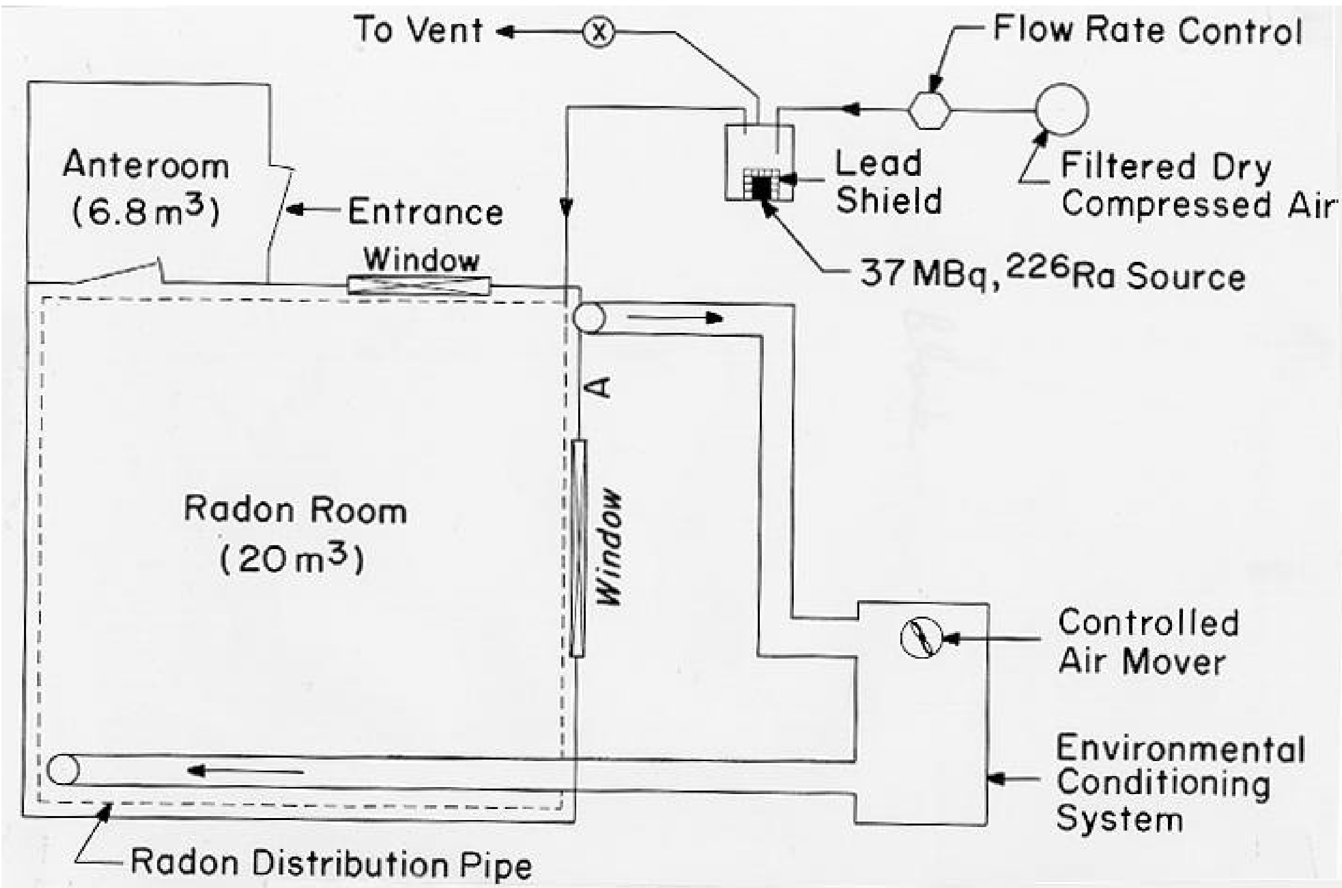

Figure 6.2 Schematic drawing of radon/thoron and progeny exposure facility.

6.3 CHEMISTRY CLEAN ROOM FACILITY

Contact Person(s) : Thomas M. Beasley

6.3.1 SCOPE

Presented here is a description of the clean room chemical laboratory that has been in operation at EML since 1976. The facility is used for low-level trace metal analyses of biological and environmental samples for various on-going and past programs, such as, metabolic balance studies, geochronology of pollution, and atmospheric transport and deposition phenomena.

Generally, these programs require the analyses to be performed in an ultraclean environment because of the low concentrations found in many of the specimen. Typically specimens of urine, excreta, diet, fish, vegetation, air, filters, water (tap, lake, rain), sediments, and soil have been analyzed for more than 20 environmentally significant trace metals.

6.3.2 FACILITY LAYOUT

A diagram of the facility, its equipment, and instrumentation is shown in Figure 6.3. Note that one entry serves as the change room and also houses the air handling system. The other entry houses the gas cylinders that are required by the instruments.

6.3.3 AIR CLEANING SYSTEM

Clean air is supplied to the room through 16 high efficiency particulate air filters suspended directly over the workbench, located in the center of the room. This down ward flow of air maintains Class 100 conditions (as defined in Federal Standard 209B, 1973) at the top of the workbench. The same air flow maintains Class 2000 conditions in other areas of the facility.

The air handler supplies sufficient clean air to maintain positive pressure in the clean room, even with the fume hood and the furnace hood in operation.

6.3.4 MONITORING OF CLEAN ROOM OPERATION

To check that the facility is operating properly, particle concentrations are monitored with a Royco particle counter. In accordance with Federal Standard 209B, this counter is set to measure the concentration of particles with diameters larger than 0.5 µm.

6.3.5 **PERMANENT APPARATUS**

The clean room chemical laboratory is equipped for all stages of analysis of trace metals in various biological matrices from sample preparation to final measurements.

The following are the major instruments used in the clean room.

Atomic Absorption Spectrometer
Model 603
Perkin-Elmer Corp.
Norwalk, CT 06859-0001

Direct Current Plasma Emission Spectrometer
Model SMI II
Spectrametric, Inc.
Valencia, CA 91355

The basic attributes of both instruments are well-documented in the scientific literature; e.g., Dean and Rains (1971), and details are given in the manufacturer's instrument manuals. At EML, both instruments are used to verify the results by two distinct techniques and where the matrix and/or the concentration range of the specimen prohibits accurate and precise measurement on one instrument.

The clean room can produce both ultrapure deionized water and a sub-boiling distillation apparatus. The clean room is also equipped with a freezer, refrigerator, muffle, drying oven, and several analytical balances.

REFERENCES

Dean, F. and T. Rains
"Flame Emission and Atomic Absorption Spectrometry"
Marcel Dekker Inc., New York (1971)

Federal Standard 209B
"Federal Standard Clean Room and Work Station Requirements, Controlled Environment"
Available from: General Services Administration, Specifications Activity, Printed Materials Supply Division, Washington, DC 20407

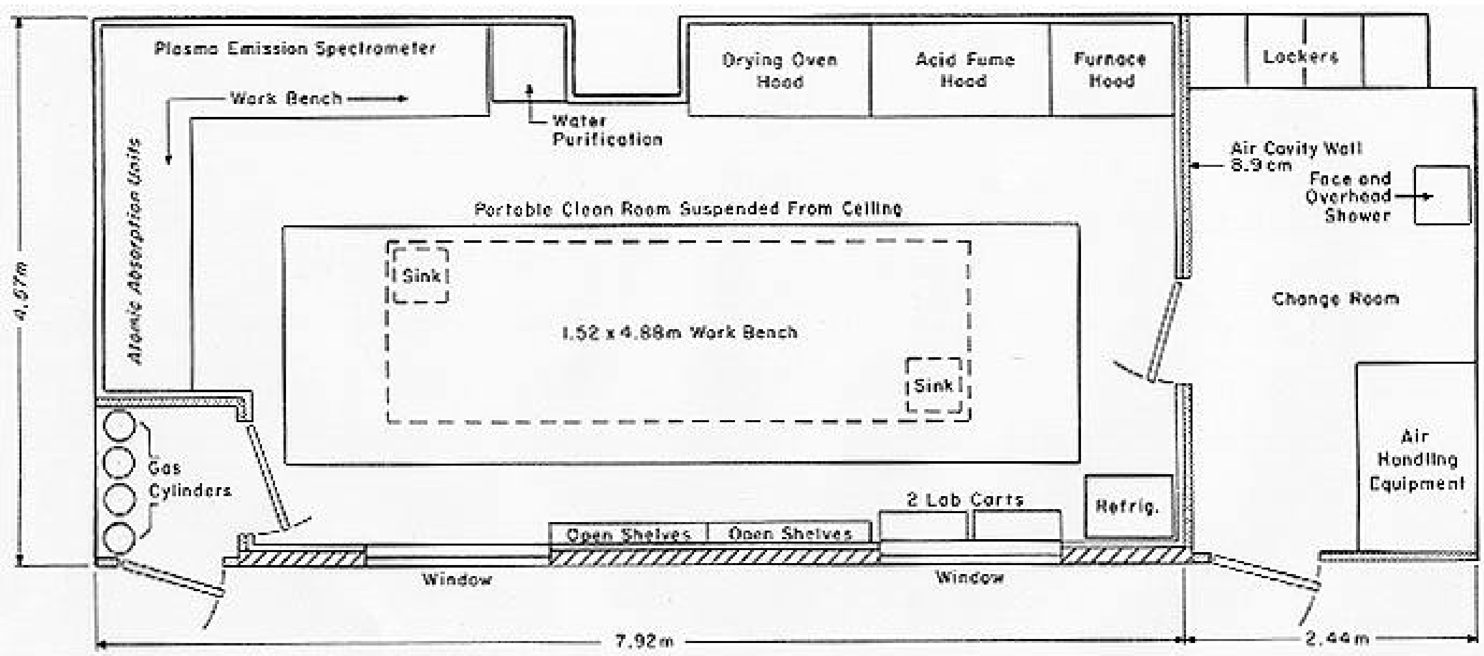

Figure 6.3 Diagram of EML's clean room facility.

6.4 SCANNING ELECTRON MICROSCOPE FACILITY

Contact Person(s) : Robert Leifer

6.4.1 SCOPE

This section describes EML's scanning electron microscope (SEM) facility. The physical layout of this facility is shown in Figure 6.4. The SEM is used to: 1) analyze aerosols collected from the troposphere and the stratosphere (Kromidas et al., 1996); 2) characterize laboratory-generated aerosol; and 3) analyze biological samples.

6.4.2 SAMPLE PREPARATION ROOM

The sample preparation room is maintained under clean-room conditions using high efficiency particulate air (HEPA) ceiling filters. The air is recirculated and controlled with a system that is independent of the building air delivery system. There are two Class-100 benches to provide additional cleanliness for sample preparation and for the preparation of sampling equipment. The first, an exhausting laminar bench (Advanced Purification Inc., Hauppauge, NY 11788; Model G68-PD) allows the use of various solvents and provides a Class 100 environment for equipment setup and preparation of biological samples. The second bench (Laminar Flow Inc., Ivyland, PA 18974; special order) is a recirculating vertical laminar flow system with two cartridges that contain molecular sieve 5A and activated charcoal. These cartridges remove substances from the airstream that may interfere with aerosols. Such interfering substances include ammonia, water vapor, and organics.

6.4.3 MICROSCOPE ROOM

The microscope room is also maintained under clean-room conditions using HEPA ceiling filters.

6.4.3.1 SCANNING ELECTRON MICROSCOPE

The SEM is an AMRAY-1820 (AMRAY, Bedford, MA 01730) and has a 150-mm specimen chamber and a resolution of 5 nm. The SEM may be operated at low voltages (~1 kV), thus allowing imaging of samples without prior preparation. Microprocessor controlled operations permit automatic image focusing and stigmation and provides push button digital magnification from 25X- 400,000X at a 12 mm working distance. However, just how much of this magnification is usable depends heavily on the contrast characteristics of the sample. The SEM is supplied with a solid-state backscatter detector. This detector produces images which emphasize maximum atomic number differences. The resulting image shows contrast differences that can be related to differences in trace element composition. The SEM is also supplied with an X-ray/imaging system (described below). This system controls the sample stage automatically and thus allows for unattended X-ray analyses, imaging, and sample characterization of more than 100 different fields.

The whole microscope assembly is isolated on a Micro-g vibration isolation table (TMC, Peabody, MA 01960).

6.4.3.2 **MICROANALYSIS SYSTEM**

The microanalysis system used in conjunction with the AMRAY 1820 SEM is the PGT IMIX system with a two position light element Si(Li) energy dispersive spectrometer (Model 4200 EDS, Princeton Gamma-Tech, Princeton, NJ 08540). The PGT IMIX system is equipped with:

1. An ultrahigh resolution 19-in color display.
2. Dec 11/73 high performance processor with floating point.
3. SPARC station 1+ (SUN Microsystems) with a built-in, 3 1/2" floppy disk drive, external CD ROM drive, and a 1.27 gigabyte Fujitsu drive.
4. Two thousand channel data collection system.
5. Pulse processing electronics.
6. EDS X-ray analysis software.
7. Qualitative and quantitative analysis software.
8. Chemical classification software.
9. PGT beam control package.
10. Advanced feature analysis package.
11. Mega plane option (800 x 1040 pixel image).

The microanalysis system allows detailed chemical and size classifications of samples. In the windowless mode, the model 4200 EDS allows the analysis of X-rays with energies down to 700 eV. In this position, detection of B, C, N, and O is possible, as well as enhanced detection of F, Na, Mg, and Al. The PGT beam control package allows automated analysis of specific points on a collection surface by controlling the scan coils of the microscope column. Up to 300 points can be automatically stored for later use.

The PGT imaging system is connected to the Tissue Culture Facility via a video cable that is attached to a CCD video camera and can capture images from the optical microscopes.

6.4.3.3 SAMPLE CRITICAL POINT DRYING AND COATING EQUIPMENT

The sample coating equipment consists of a Denton high vacuum evaporator (Denton Vacuum, Inc., Cherry Hill, NJ 08003), an EFFA Carbon Coater (Ernest E. Fullam Co., Latham, NY 12110; Model No. 12560), and a sputter coater (Polaron, Warrington, PA; Model E5000). The sputter coater is supplied with platinum, gold, and silver targets. The carbon coater and sputter coater, plus an optical microscope are housed in a vertical flow class 100 laminar clean bench (Laminaire Corp., Rahway, NJ 07065; Model DWS-630).

Critical point drying of biological samples is accomplished via the Balzers CPD 030 using acetone as the transfer medium and liquid CO_2 as the transition liquid. The CPD 030 is located in the Sample Preparation Room with access to the exhaust laminar flow bench.

6.4.4 QUALITY CONTROL

When using an SEM, several things should be kept in mind. The sampling process must be conducted very carefully to provide the microscopist with a representative sample of the material of interest. Many methods of sampling introduce bias in that their collection efficiency varies with particle size. The internal environment of the microscope should also be taken into account. In order to function, the column is kept at a high vacuum (10^{-5} Torr) and there can be large amounts of heat generated in the sample by electron bombardment. These conditions can alter or destroy susceptible samples. Contamination is always a concern. Considering the size of the particles of interest, unless strict sample handling procedures are followed, contributions from contaminating sources may outweigh the sample material.

REFERENCE

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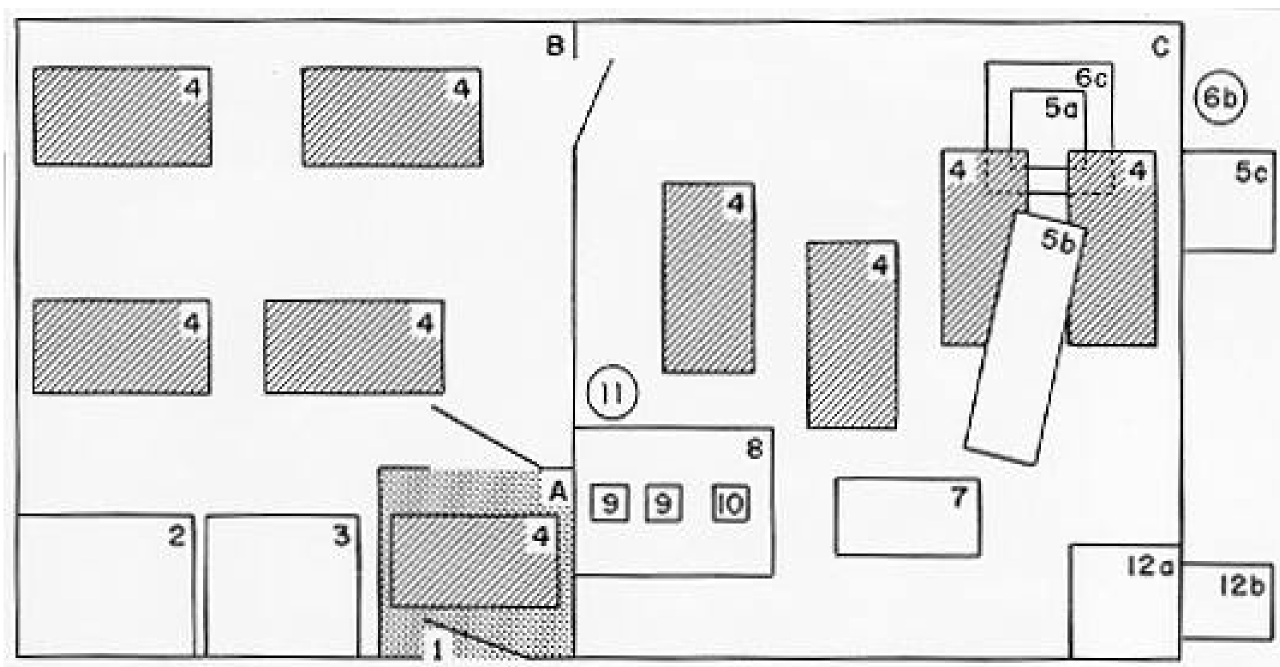


Figure 6.4 SEM facility: A) clothing change room; B) sample preparation room; C) SEM room. Areas in rooms: 1) sticky floor mat; 2) exhaust laminar flow bench; 3) recirculating laminar flow bench; 4) HEPA ceiling filters with blowers; 5a) column and stage; 5b) SEM electronic console; 5c) SEM vacuum, air and water support module (equipment placed outside microscope room); 6a) Micro-g vibration table; 6b) air supply for Micro-g table; 7) PGT microanalysis system; 8) vertical laminar flow bench; 9) particle coating devices; 10) optical microscope; 11) tank of Argon; 12a) Denton high vacuum evaporator; 12b) evaporator and coating device vacuum, air and water module.

6.5 MOBILE RADIATION MEASUREMENTS LABORATORY

Contact Person(s) : Kevin M. Miller

6.5.1 SCOPE

We describe here a customized motor vehicle that is used by EML as a self-contained work station during field trips. Its primary function is for conducting radiation measurements in the environment, the main feature being a shielded Ge detector for γ-ray spectral analyses of collected samples. A certain flexibility in design is achieved with the use of roll out electronic equipment racks which facilitate adaptation to different projects and/or changes in instrumentation.

6.5.2 BASE VEHICLE

The base vehicle was purchased in two parts: the van chassis, which includes the cab and engine, and the truck body, which is essentially the box placed on the rear end of the chassis. A photograph of the complete vehicle is shown is Figure 6.5. A breakdown of the major specifications follows.

A. Chassis.

1. 1982 Ford E-350 dual rear wheel chassis, 4.01 m wheel-base (Ford Motor Company, Dearborn, MI 48121)
2. 7.5 L V-8 gasoline engine
3. Automatic transmission
4. Power steering
5. Power brakes (front disc)
6. Front stabilizer bar
7. Heavy duty springs and shock absorbers
8. 100 A alternator
9. 80 A-hr battery
10. Heavy duty cooling system
11. Tinted glass
12. Auxiliary fuel tank [with main tank - 152 L (40 gal) total capacity]
13. Transmission cooler
14. External oil cooler
15. Cruise control

16. Reclining swivel captain seats (two)
17. Recreational-type swing out side mirrors
18. Interval wipers
19. Trailer hitch
20. AM/FM radio
21. Digital clock
22. C/B radio

B. Body.

1. Grumman-Olson Kurbette (Grumman Olson, Division Grumman Allied Industries, Inc., Melville, NY 11747)
2. Interior length, 3.96 m
3. Interior width, 2.29 m
4. Interior height, 1.85 m
5. Double rear doors with windows
6. Single curb side door with window

C. Full vehicle specifications.

1. External length, 6.68 m
2. Overall height, 2.72 m
3. Gross vehicle weight, 4649 kg
4. Tare weight (before customizing), 2492 kg
5. Load capacity, 2157 kg

6.5.3 CUSTOMIZED COMPONENTS

A commercial van customizer (East Coast Vans and Campers, Inc., West Babylon, NY 11704) was used to finish the interior of the cargo section of the vehicle and to provide the electrical systems, climate control, cabinetry, and mounting arrangements for equipment. Interior layout is shown in Figure 6.6. Specific features are as follows.

A. Interior finish.

1. Wall and ceiling - lined with plywood and covered with washable white marlite board
2. Insulation (walls, doors, and ceiling) - R-11 foiled fiberglass wool
3. Floor - sheet vinyl with metal bright molding

B. Electrical.

1. Generator - Kohler model 4.5CKM21-RV, 1800 rpm, 2 cylinder, 4500 W, 120 V AC, 37.5 A, 60 Hz with high temperature-low oil shutdown, battery charger, air-vac cooling (Kohler Company, Kohler, WI 53044). Starting is electrical using vehicle battery via interior panel that features elapsed time of operation. Unit is mounted in a sound absorbent enclosure and is serviceable from both interior and exterior panels. Fuel is gasoline, fed from the vehicle's main tank.
2. Circuit box panel with four breakers
3. Four duplex 120 V wall outlets
4. Outside 120 V shoreline weather protected input box with 15 m extension line (provides power when available from an external source)
5. One 1.2-m dual, and two 0.6-m quadruple fluorescent light fixtures
6. Rotary warning lamp mounted on cab roof
7. Two outside 12 V spot lamps installed on front pillar posts

C. Climate control.

1. Coleman TSR Mach 3 13,500 BTU rotary compressor type, 115 V, 60 cycle, 1 phase air conditioner (Coleman Company, Inc., Wichita, KS 67201) mounted on roof with added support beam and columns. Unit also provides 5600 BTU heating.
2. 0.3 m square crank operated screened roof vent
3. One 0.35 m x 0.46 m and one 0.35 m x 0.76 m sliding screened side windows

D. Cabinetry (formica covered).

1. Overhead steel storage rack 1.83 m long x 0.3 m deep
2. Counter top 1.83 m long x 0.6 m deep, desk height with drawer and cabinets (0.281 m^3), and motor generator compartment (0.4 m^3) underneath
3. Floor to ceiling assorted cabinet units over each rear wheel well (0.7 m^3 each)
4. Floor to ceiling cabinet 0.38 m deep x 0.61 m wide in rear (0.4 m^3)

E. Miscellaneous.

1. Swivel passenger-work seat
2. Steel frame for 135 kg radiation shield
3. Wall and floor mounts for roll out electronic equipment racks
4. Floor mounted rings for detector and storage dewar placement
5. Temperature and humidity gauge (inside)
6. Fore and aft wall mounted fire extinguishers (type A, B, C)

6.5.4 OUTFITTING

A photograph of the finished interior with some of the instrumentation carried is shown in Figure 6.7. Typical instrumentation and equipment carried on an extended field trip for environmental radiation measurements include the following.

A. Instrumentation.

1. Ge detector (17 L dewar) in shield
2. One roll out cabinet containing
   a. Tracor-Northern TN-1750 4000 channel pulse height analyzer
   b. Hewlett-Packard 9825B computer
   c. Computer interfaces
   d. Disk drive for above
   e. NIM power supply with HV and spectroscopy amplifier modules
3. Hand-held Ge detector
4. Canberra Series 10, 8000 channel portable battery powered pulse height analyzer
5. Battery charger for above
6. Portable cassette data recorder and tapes for Series 10 analyzer
7. Ionization chamber survey instrument (SPICER, Latner et al., 1983)
8. Electronic analytical balance (0-30 kg ± 1 g)
9. Tracor-Northern TN-1705 1000 channel pulse height analyzer
10. Portable cassette data recorder and tapes for above
11. Oscilloscope modules (adapts to TN-1705 analyzer)
12. Porta-Nim power supply
13. Multitester
14. Portable scintillation exposure ratemeter (KLERUS, Latner et al., 1985)
15. Miscellaneous cables and connectors
16. Instruction and service manuals
17. Calibration and radiation data tables
18. Check sources
19. Computer analysis software and data storage media (diskettes and tapes)
20. Magnetic shielded diskette and tape storage box
21. 120 V AC power extension lines

B. Miscellaneous equipment.

1. 50 and/or 30 L liquid N_2 storage tanks with transfer hoses
2. Soil sampling gear (corers, augers, templates, mallets, bags, pails)
3. Soil preparation gear (pans, spatula, mixing claw, Marinelli beakers)
4. Stakes, rope, tape measurer
5. Pressure meter (barometer)
6. Tool kit
7. Water jugs
8. Ice chest
9. Electric fan
10. Large plastic bags
11. 300 W portable back-up motor generator
12. Assorted stationery and office supplies
13. Maps
14. Data log books
15. Hot air gun
16. Vacuum cleaner
17. Freon solvent
18. Binoculars
19. Camera, film
20. Wet suits, gloves

C. Safety and emergency equipment.

1. First aid kit
2. Snake bite kit
3. Fire rescue blanket
4. Road hazard markers
5. Tow line
6. Hydraulic jack
7. Spare tire
8. Flashlights
9. Battery charger
10. Booster cables
11. Air compressor

REFERENCES

Latner, N., K. M. Miller, S. Watnick and R. T. Graveson
"SPICER: A Sensitive Radiation Survey Instrument"
Health Phys., Vol. 44, 4, 379-386, April (1983)

Latner, N., S. Watnick, V. C. Negro and R. T. Graveson
"KLERUS: An Energy Independent Gamma Survey Meter"
USDOE Report EML-446, October (1985)

Figure 6.5 View of van exterior.

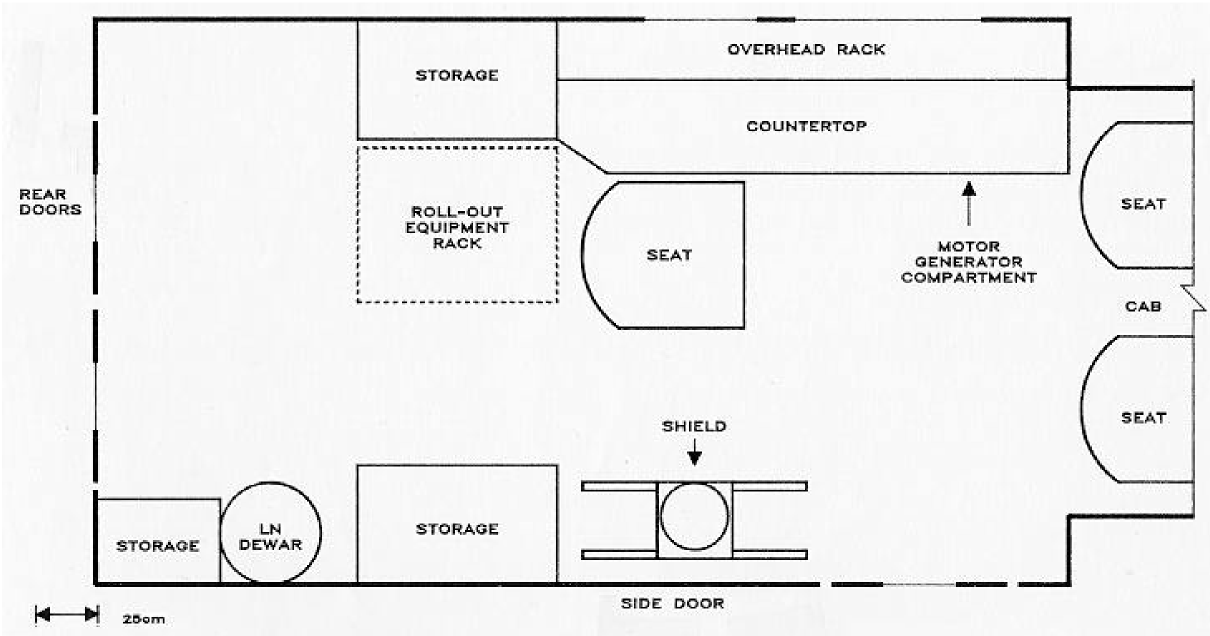


Figure 6.6 Schematic of interior layout.

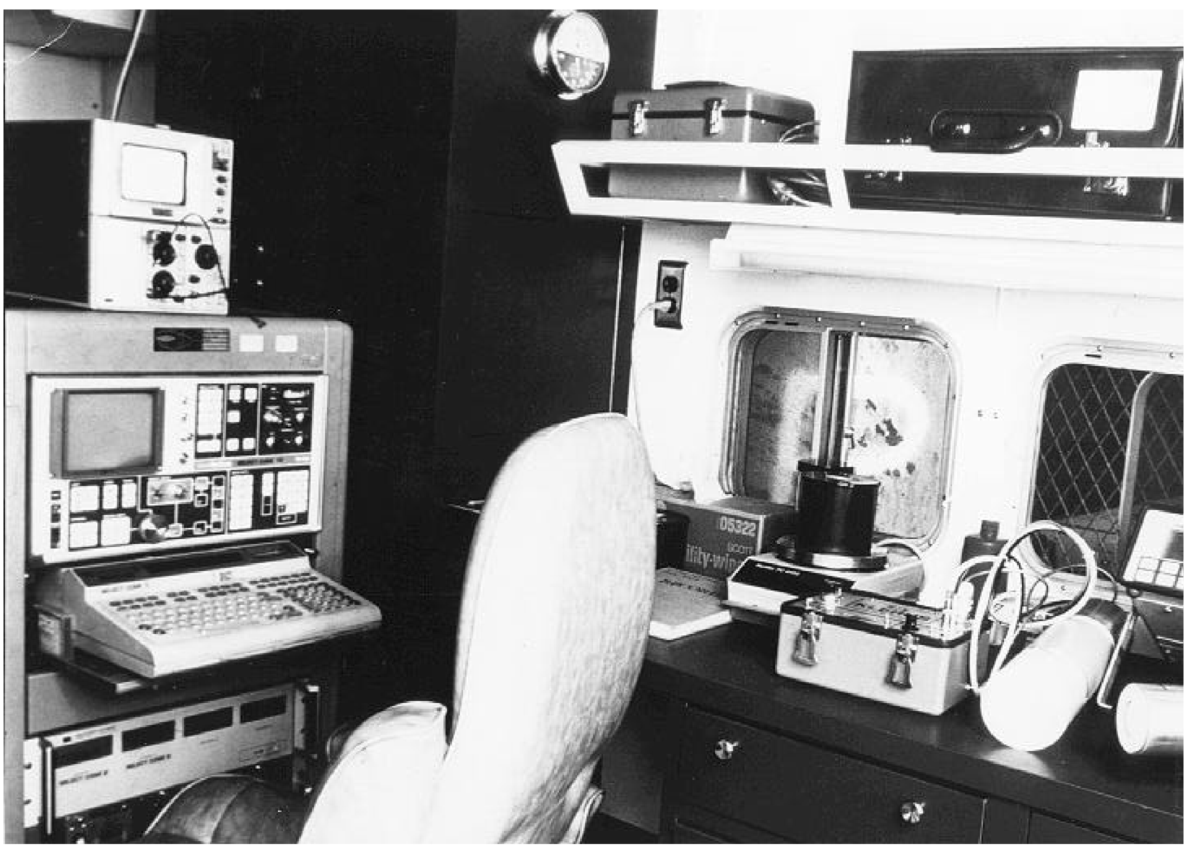


Figure 6.7 View of van interior with equipment.

6.6 WORK BOAT AND TRIPOD CORER

Contact Person(s) : Mathew A. Monetti

6.6.1 SCOPE

The main focus of this section is to present an overall description of the EML research vessel, Sedimental Journey, including its associated trailer and large diameter sphincter corer. Sedimental Journey is used for taking sediment cores from inland lakes as a means of reconstructing the deposition history of energy-related pollutants in different regions of the U.S. (Heit et al., 1981). The sampling procedure itself is discussed in Section 2.5 of this Manual.

6.6.2 RESEARCH VESSEL SEDIMENTAL JOURNEY

6.6.2.1 DIMENSIONS AND CONFIGURATIONS

Sedimental Journey is an outboard-powered aluminum boat. It was specially designed and constructed by Winninghoff Boats, Inc. (Warehouse Lane, Rowley, MA 01969). The principal dimensions of the boat and some accessory items are listed in Table 6.1. A photograph of Sedimental Journey is shown in Figure 6.8.

The main feature that distinguishes this boat as a sediment coring research vessel is the well in the stern section of the hull. This craft has the maximum beam size (2.6 m) that can legally be trailered by someone with a standard driver's license. There is some cabin space in the bow that is primarily used for dry storage. The captain's chair and steering wheel are located on the forward starboard side. This midship area is protected by a permanently mounted windshield, as well as a collapsible canvas cover. There are storage brackets available for the disassembled coring device along each side of the boat. The winch motor and spool are bolted directly onto a plate on the hull. The boat has four mounts along the gunnels in the stern (two on each side) which are used to attach the quadrapod.

6.6.2.2 POWER EQUIPMENT

Sedimental Journey is powered by a pair of 30 kW (40 horsepower) Evinrude outboard engines. The controls for these motors are visible on the starboard deck in Figure 6.8.

A gasoline powered winch is installed on the starboard deck in front of the control console. Information about the winch is given in Table 6.1. The winch, together with the quadrapod mounted over the well, are used to lower the tripod corer to the lake bottom for sampling, and to retrieve it after sampling. The quadrapod is clearly visible as the tallest structure on the deck in Figure 6.8.

6.6.2.3 DEPTH RECORDING GEAR

Two devices are available for measuring depths. One is a mechanical system mounted on the cable sheave at the top of the quadrapod, which records the length of cable payed out. The second device on board is a recording fathometer (Low Range Model X-16). This unit is capable of measuring depths to 300 m. The transducer is mounted on the rear underside of the hull. The display is placed on a bracket so that it is visible from the captain's chair. The boat has a Loran unit for locating geographical positions and determining bearing. This micrologic explorer model unit is mounted next to the fathometer display. The receiving antenna is positioned along the port side. For emergency communications, Sedimental Journey is also equipped with an ICOM VHF radio. The radio is mounted beside the Loran unit and has an antenna off the starboard side.

6.6.3 TRAILER AND TOWING VEHICLE

The trailer used to transport the boat is a commercially available E-Z loader, with a maximum weight capacity of 2,000 kg. The towing vehicle is a four-wheel drive Chevrolet 4x4 pickup truck with a 5.7 L V-8 engine and an automatic transmission with four-wheel driver transfer case. A Class III load-equalizing type hitch and antisway bars are used to stabilize the ride.

6.6.4 TRIPOD CORER

Figure 6.9 shows the assembly that is lowered through the well in the hull of Sedimental Journey, to the bottom of the lake or reservoir to be sampled. It consists of three main subassemblies: the coring tube and its attachments, the frame, and the weight stand.

The operation of the sampling assembly is described in Section 2.5.3.3, but a brief overview is useful here. When the tripod contacts the bottom, a catch is released and gravity drives the coring tube (marked "core barrel" in Figure 6.9) into the sediment. The depth of penetration depends on the nature of the sediment and on the number of lead weights placed in the weight basket. When the winch has started to raise the assembly (usually after 1 min of penetration), the initial tension on the cable acts to close the sphincter valves at both ends of the coring tube. This done, the cable pulls the coring tube out of the sediment back into the frame. Finally, continued pulling on the cable raises the entire assembly back to the deck of Sedimental Journey.

Sampling operations are most convenient with a crew of three or four. The skipper maneuvers the boat on the sampling station and operates the recorder, while one crew member operates the winch which has separate throttle, brake, and clutch controls and thus requires their full attention, and the remaining crew members handle the sampling gear.

6.6.4.1
CORING TUBE AND ATTACHMENTS

This subassembly consists of a 1 m or 1.5 m length of tubing, labeled "core barrel" in Figure 6.9, with fittings at both ends. The tube is made of fiberglass, although Lucite tubes can also be used. The outside diameter is 21.9 cm and the wall thickness is 3 mm.

The fitting at the lower end is called the "core catcher" and consists of a stainless steel sleeve fitted over the coring tube. The sleeve provides the edge that cuts into the sediment, as well as the mechanism to close the bottom of the tube after coring.

The fitting at the upper end of the coring tube is also a stainless steel sleeve. It carries the valve mechanism used to close off the top end of the coring tube after the core is taken.

A further description of this subassembly can be found in Burke (1968) and in Burke et al. (1983).

6.6.4.2
FRAME

The frame consists of a top plate, a guide ring, and three legs, and is assembled from its components before launching Sedimental Journey. Assembly involves installing 15 bolts. Two of the legs fold so the corer can fit through the well in the hull. Once the corer is in the water, but before the corer is lowered to the sediment, the collapsed legs are manually swung out and locked with a spring-loaded pin.

The guide ring, together with the vertical support shown in Figure 6.9, serve to steer the coring tube vertically into the sediment during sampling.

6.6.4.3 WEIGHT BASKET

Up to 14 lead weights, each 13.6 kg, can be loaded onto the tripod corer to provide the force needed to drive the coring tube into the sediment. These weights are specially shaped to fit into the bucket-like structure labeled "weight basket" in Figure 6.9.

6.6.4.4 CORE EXTRUDER

The extrusion sampling method is described in Section 2.5.4.4. The core extruder mechanism is simple and easy to use (see Figure 6.10). The basic components consist of the following. A flat aluminum plate (50 cm x 50 cm) with two pins (one in the center and one off to the side) is used as the base. Two pieces of galvanized pipe (5 cm in diameter) are used for support. One piece is 1.5 m long and is fitted over the centered base pin. The other piece (2 m) is marked with a scale of holes drilled down the length of the pipe, and it fits over the side pin. The core with the piston in place on the bottom is positioned onto the center pipe. A clamp with a loop is placed over the large pipe and tightened around the core. As the core barrel is pulled down, sediment is forced out of the top. The scale on the large pipe is used to regulate the depth of each section removed from the core. Locking pliers can be used to mark the stop points on the scaled pipe so that sections are one or more centimeters thick.

6.6.5 ASSEMBLY, LAUNCHING AND RETRIEVAL PROCEDURE

The quadrapod and corer are assembled before the boat is launched. Sedimental Journey is launched by backing the trailer down a ramp and into the water. Once the boat contacts the water, the brakes are applied and the boat gently slips into the water. The trailer is then pulled out of the water and parked. The launching procedure takes about one-half hour to complete. Retrieval of Sedimental Journey is essentially a reversal of the launching, except that the boat is pulled onto the submerged trailer with a manual winch. The coring gear is then disassembled and stored before transporting the boat.

REFERENCES

Burke, J. C.
"A Sediment Coring Device of 21-cm Diameter With Sphincter Core Retainer"
Limnology and Oceanography, 13, 714-718 (1968)

Burke, J. C., R. E. Hamblin and S. A. Casso
"Tripod Modification of Sphincter Corer: Construction, Operation, Core Extrusion and Sampling Efficiency"
Woods Hole Oceanographic Institution Technical Report WHOI-83-36, Woods Hole, MA 02543,1-13 (1983)

Heit, M., Y. L. Tan and C. S. Klusek
"Anthropogenic Trace Elements and Polycyclic Aromatic Hydrocarbon Levels in Sediment Cores From Two Lakes In The Adirondack Acid Lake Region"
Water, Air, and Soil Pollution, 15, 441-464 (1981)

TABLE 6.1

NUMERICAL DATA ON THE RESEARCH VESSEL SEDIMENTAL JOURNEY

Principal Dimensions:	
Hull	
Length	9.0 m
Weight	900 kg
Material	3/16 " (0.5 cm) aluminum
Draft	7.0 cm
Beam size	2.6 m
Gunnel height	70.0 cm
Well	
Length	1.8 m
Width	0.8 m
Accessory Equipment:	
Propulsion	
Outboard Motors (2)	
Evinrude Outboards	18.6 kW (40 Hp)
Winch (modified Hydro Products Model HR-35, gasoline-engine powered,engine)	
Cable diameter	4.8 mm
Cable length	305 m
Rated load capacity	726 kg
Lifting speed	20 m min^{-1}
Quadrapod (mounted on deck centered over well; used with a winch for raising/lowering samplers; disassembles for over the road travel)	
Diameter of legs	0.05 m
Length of legs	3.05 m
Safe working load	
Quadrapod (mounted on deck centered over well; used with a winch for raising/lowering samplers; disassembles for over the road travel)	
Diameter of legs	0.05 m
Length of legs	3.05 m
Safe working load	907 kg
Depth Recording Gear:	
Fathometer (Low Range Model X-16)	
Depth measuring range	200 m
Loran Unit: Micrologic explorer	
VHF Radio: ICOM	
Trailer: Weight 2000 kg	

Figure 6.8 Photograph of Sedimental Journey afloat. The quadrapod and coring device are visible in the stern of the boat.

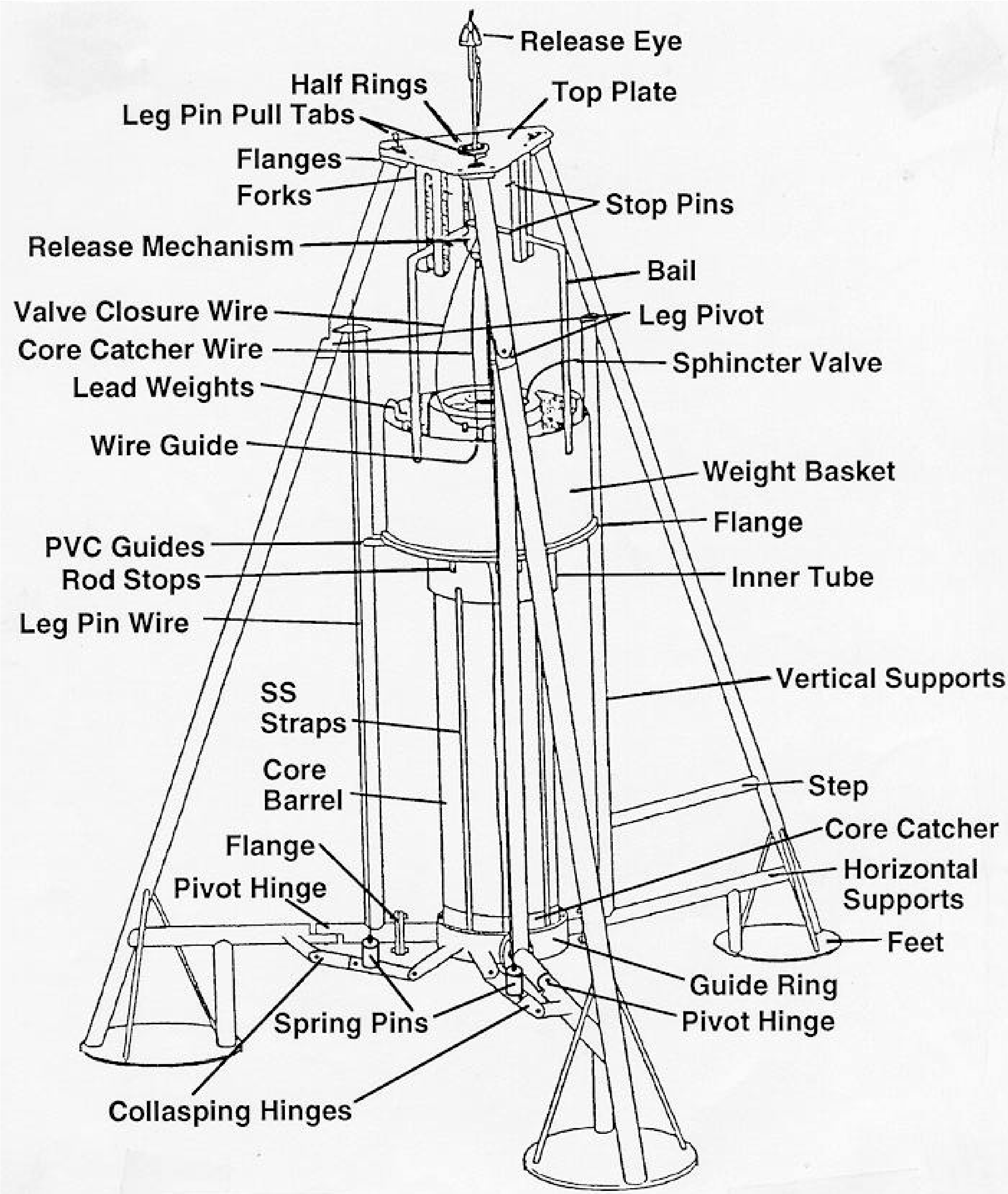


Figure 6.9 Detailed schematic of tripod corer.

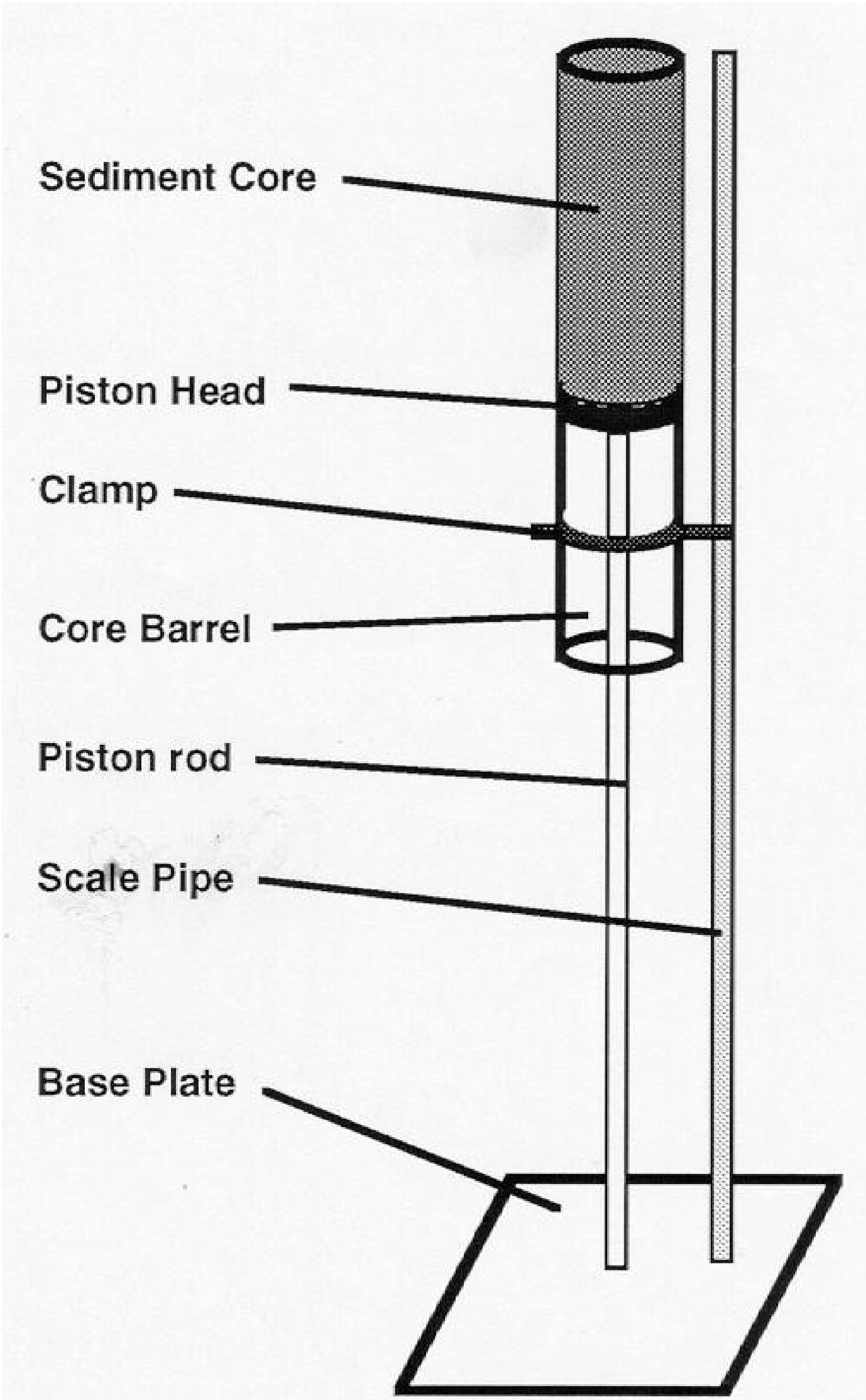


Figure 6.10 Diagram of extruder used to section sediment cores.

6.7 CHESTER REGIONAL BASELINE STATION

Contact Person(s) : Brian Albert

6.7.1 SCOPE

The location, site characteristics, and permanent facilities of the field station operated by EML at Chester, NJ, are described here. The station is used by EML as a site for environmental research and for field testing of environmental instruments. Both short- and long-term research and testing programs are carried out, but our purpose here is to describe the site and the facilities - not the programs. Reports on the programs can be found in a series of USDOE Reports, and the latest publication in the series is USDOE Report EML-538.

6.7.2 LOCATION

The EML Regional Baseline Station, henceforth called EML/Chester, is located about 64 km west of the Laboratory, on the grounds of the Chester, NJ, unit of Bell Communications Research (BCR). Table 6.2 shows the latitude, longitude, and elevation of EML/Chester, and the distance to nearby areas. Table 6.3 gives the distance and direction from EML/Chester to major metropolitan areas. Similar information for coal-burning electric generating stations is shown in Table 6.4.

6.7.3 LOCAL TERRAIN, SOIL, AND VEGETATION

Figure 6.11 is an aerial photograph showing EML/Chester and the surrounding area. The view is westward, across the station which is the fenced rectangular area in the center foreground. It is seen that the general environs consist of rolling hills with a mixture of fields and woods.

The ground slopes at about 12% from the upper right to the lower left (NW to SE). The research station is located about 200 m south and about 10 m below the nearest high ground.

Figure 6.11 also shows that the research station is located at the southern edge of a cleared field, with a wooded area about 15 m to the south. There is also a wooded area about 75 m to the north-northeast. To the west, the direction of the prevailing winds, there is a fetch of about 150 m to the line of trees along Dover-Chester Road. The trees in all cases are deciduous and their average height is about 15 m.

The cleared area around the station is grass-covered. BCR personnel keep the grass cut to a height not exceeding 20 cm. The grass within the station fence is kept to about 10 cm by cutting with conventional power lawn mowers (also by BCR personnel).

Information of the radionuclide content of the soil at EML/Chester can be found in EML-347 (1978, p. 146).

6.7.4 SITE CHARACTERISTICS AND PERMANENT FACILITIES

EML/Chester is situated on a 15.2 x 61 m area of ground, and is surrounded by a 2.4 m high chain-link fence. The fence provides additional security for the site. (The first line of security is provided by the fact that the site is on property owned by BCR.)

Figure 6.12 is a plan view of EML/Chester. A 2.4 x 6 m enclosed trailer serves as a communications center and staging area for experiments at the research station. Electric service totaling 45 kW is brought into the trailer via underground cables; both 120 and 240 V are available. The trailer's interior is temperature-controlled to protect the most delicate equipment.

A computer link using commercial telephone lines is available between the EML/Chester site and the Laboratory in New York. This provides semicontinuous communication, particularly important after installation of new or critical experiments and to promptly alert the researchers to events of interest or problems.

Six redwood platforms are provided for mounting long- and short-term outdoor experiments. Each platform has electric service and wiring for data communications. High volume aerosol samplers and an environmental Rn monitor are examples of the experiments mounted on these platforms (see Section 6.8.5).

The southwest end of the enclave is set aside for measurements of environmental radiation. High pressure pulse ionization chambers for measuring the γ field are an example of the equipment installed here. A telephone pole (11.5 m) is provided for use in measuring vertical gradients.

At the northeast end of the enclave there is a 10 m meteorological tower, with instruments mounted at the 1 m and 10 m levels. The meteorological instruments, which comprise the bulk of the permanent instrumentation at the site, are described in the next section.

6.7.5 **METEOROLOGICAL DATA INSTRUMENTATION**

The instrumentation presently being used at the site, see Table 6.5, include rain gauges, a solar pyranometer, a wind vector transmitter, a temperature and dew point sensor, and a barometric pressure sensor. The wind instrument is located atop a 10 m tower and provides the X and Y components of the wind vector. In an area free from shadows is a solar pyranometer which measures the total solar radiation reaching the earth's surface. Precipitation amounts are also continuously monitored using two heated tipping bucket rain gauges and one weighing bucket rain gauge. An aspirated temperature and dew point sensor has been installed at a height of 1 m. Signals for all sensors are recorded on magnetic cassette tape using a data acquisition system designed by EML. The data acquisition system is operated in a 6 min integration cycle, thus providing 10 average values per hour.

6.7.6 **ACKNOWLEDGEMENTS**

We acknowledge the support and cooperation of the Bell Communications Research management and personnel in all aspects of operation of the Regional Baseline Station.

REFERENCES

"EML Regional Baseline Station at Chester, NJ"
USDOE Report EML-347, October (1978)

"EML Regional Baseline Station at Chester, NJ"
USDOE Report EML-538, December (1991)

Groff, J. A. and Gratch, S.
Trans. Amer. Soc. Heat. Vent. Eng., 52, 95 (1946)

TABLE 6.2

LATITUDE, LONGITUDE, ELEVATION, AND IMMEDIATE SURROUNDINGS OF EML/CHESTER

Latitude	40º 47' N
Longitude	74º 40' W
Elevation	268 m MSL
Distance and direction to--	
BCR Admin. building	244 m SSW
Town of Chester, NJ	1.2 km SW
Dover - Chester Road	150 m NW

TABLE 6.3

DISTANCE AND DIRECTION TO MAJOR METROPOLITAN AREAS FROM EML/CHESTER

Metropolitan Area	Distance and Direction
Manhattan, NY	64 km E
Newark, NJ	44 km ESE
Trenton, NJ	66 km S
Philadelphia, PA	94 km SSW
Allentown and Bethlehem, PA	66 km WSW
Scranton, PA	112 km NW

TABLE 6.4

DISTANCE AND DIRECTION TO MAJOR COAL-FIRED
POWER PLANTSFROM EML/CHESTER

Plant Name	Distance and Direction
New Jersey:	
Hudson	51 km ESE
Mercer	63 km S
Vineland	151 km S
Pennsylvania:	
Eddystone	117 km SSW
Hatfield	80 km SW
Keystone	211 km WSW
Martin's Creek	43 km W
Sunbury	181 km W
Hunlock Creek	129 km WNW
Montaur	201 km WNW
Portland	38 km NW

TABLE 6.5

METEOROLOGICAL INSTRUMENTS

Precipitation

a. Belfort Instrument Company: Model 5-405-1 - heated tipping bucket rain gauge (two).
b. Belfort Instrument Company: Model 5-780 - universal recording rain gauge.
c. Environmental Measurements Laboratory - trace precipitation sensor.

Solar Radiation

Eppley Laboratory Inc.: Eppley black and white pyranometer, Model 8-48 (horizontal surface receiver - 180^{o}).

Temperature and Relative Humidity

Model 8151-A - aspirated temperature and humidity shield, with Model 4480-A temperature sensor and Model 5120-D Humidity - Qualimetrics, Inc.

Temperature, Dew Point Temperature, and Relative Humidity

Climatronics Corp.: A Model TS-10WA aspirated temperature and dew point shield, with Model 100093 temperature sensor and Model 101197 lithium chloride dew point sensor.

The relative humidity is derived from the measurements of the temperature and dew point temperature and the use of the Groff-Gratch formulation for the saturation vapor pressure in the pure phase over plane surfaces of pure water (Groff and Gratch, 1946).

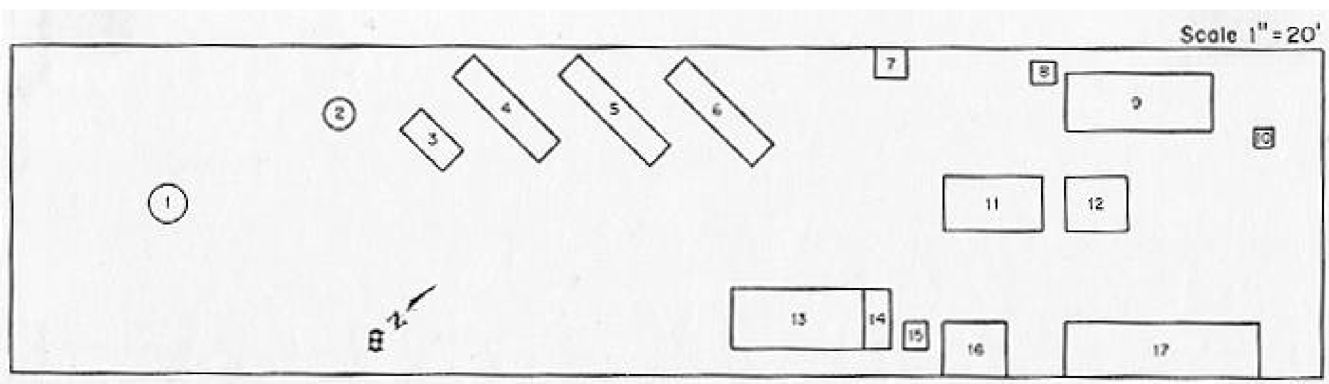
Wind Speed and Wind Direction

Vertical wind sensor Model F460 - Climatronics Corp.
Low Threshold Wind Vane Model 2005 and Low Threshold Anemometer Model 2010 - Qualimetrics, Inc.

Barometric Pressure

Analog output barometer, Model 7105-A - Qualimetrics, Inc.

Figure 6.11 Aerial photograph of Regional Baseline Station and environs.



1. HPIC, TLD's
2. Norminal 11.5m utility pole
3. Bureau of Mines Experiments
4. Bureau of Mines experiments
5. National Parks Service experiment
6. Environmental Protection Agency experiments
7. 45 KVA XMFR (200 amp. service)
8. Radiometer
9. Short Term Experiments
   Particle size samplers
   Particle efficiency sampler
10. 10m Tower
    10m Anemometer
    1m Temp.-D/P Temp.
11. Deposition Collectors
    Total Fallout Collectors
    Trace Precipitation Sensor
12. Precipitation Collectors
    Rain Gauges
13. Instrument Trailer
    Power Distribution Center
    Data Acquisition Systems
14. Utility Platform
15. Storage shelter
16. EMI 2 Filter Radon Monitor
17. Surface Air Samplers

Figure 6.12 Plan view of Regional Baseline Station.